BIOSYSTEMATIC STUDIES OF INDIAN CHIRONOMIDAE (DIPTERA)[1]

GIRISH MAHESHWARI[2] and GEETA MAHESHWARI[3]

(With three text-figures)

Key words: Biosystematics, Chironomidae, India.

The taxonomy of Indian Chironomidae attracted attention in the beginning of this century, but their biosystematics still requires attention by Indian dipterologists. The present study highlights some significant factors that require special attention in India, viz. (i) role of Chironomidae in determining water quality and typology of lakes (ii) demography, population dynamics and distribution, (iii) chironomid behaviour and (iv) phylogenetic relationship.

INTRODUCTION

The Chironomidae, a family of amphibiotic insects, have been recognized as bioindicators of water quality. Perhaps no other freshwater amphibiotic insects are more ubiquitous, inhabiting almost all the ecological niches from high altitude glacial torrents to deep eutrophic lakes and seas. The larvae (bloodworms) of some Chironomidae form an important constituent of the biological filter fauna in settling tanks and filter beds in urban water works.

Chironomid species and population composition and its temporal changes reflect sediment quality. They also play an important role in the circulation and energy flow of aquatic ecosystems. Investigations on the role of detritus-feeding benthic chironomid groups enables better understanding of natural purification and oligotrophication of water bodies. Since numerous fish species, such as ruff, carp and eel, feed on chironomid larvae, these investigations can help in fishery development in India.

SYSTEMATICS

The major work in India came from Kieffer (1910-1914), who studied the Chironomidae in the Indian Museum, Calcutta, based mainly on colour patterns and relative sizes of the body parts, particularly of the females. Edwards (1969), Tokunaga (1959), Singh (1958), Singh and Kulshrestha (1975 and 1977), Singh and Maheshwari (1986-1989), Kaul (1970), Chaudhuri and Ghosh (1981, 1982) Chaudhuri and Sinharay (1983) and Maheshwari (1986-1990) contributed to literature on Indian Chironomid fauna. Singh (1958) recorded for the first time high altitude Chironomidae above the timber-line in the Northwest Himalaya. His record of the genus *Brillia* Kieffer remains the solitary example of this Holarctic genus from India. Kaul (1970) described two species of the torrenticole Diamesinae from the same region. Singh and Kulshrestha (1977) described some Chironomidae of the Indogangetic plains. Chaudhuri and Ghosh (1981, 1982) described a new genus *Neopodonomus* from Bhutan, and some Orthocladiinae and Chironomini from eastern India. Chaudhuri and Sinharay (1983) added three new species of genus *Rheocricotopus* Thien. and Harnisch to the Indian fauna from Darjeeling and Shillong. Singh and Maheshwari (1987-89) described the Chironomidae of Chandertal Lake (4270 m above msl), Lahaul Spiti Valley, Northwest Himalaya, with five new species of *Micropsectra* and three new species of *Corynoneura* Winn. Maheshwari (1986-95) described the Chironomidae from Gangetic plain, coastal parts and high altitude regions. He also made a faunal assessment of settling tanks of

[1]Accepted February, 1996
[2]School of Entomology, St. John's College, Agra - 282 002, India
[3]Department of Zoology, B.S.A. College, Mathura, India.

the Civil Water Supply System, Agra, India. Maheshwari and Agarwal (1993) studied the *Harnischia* complex from India.

FAUNAL COMPOSITION OF INDIAN CHIRONOMIDAE

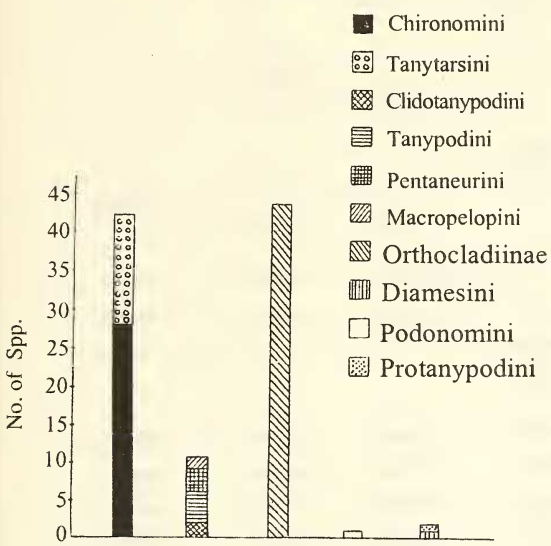

Fig. 1: Percentage analysis of species of Chironomidae from Indian limits

The material we collected represented five subfamilies: Orthocladiinae, Tanypodinae, Podonominae, Diamesinae and Chironominae, covering thirty-nine genera and 94 species. The majority were Orthocladiinae and Chironominae with 44.09% and 43.01% respectively, while Tanypodinae, Diamesinae and Podonominae were represented by 9.68%, 2.15% and 1.08% respectively.

PHYLOGENY OF CHIRONOMIDAE (FIG. 2)

Goetghebuer (1914) evaluated the phylogenetic relationships of Chironomidae. But except for his conclusion that the Chironominae were derived from the Orthocladiinae, most of his results have been found untenable. Our study reveals that the subfamily Telmatogetoninae belongs to a group with five other subfamilies viz. Podonominae, Tanypodinae, Diamesinae, Orthocladiinae, and Chironominae. These can be further divided into two phylogenetic groups of subfamilies namely Tanypodinae and Podonominae. The second group constitutes Diamesinae, Orthocladiinae and Chironominae.

ECOLOGY

No consistent work has been done on the ecology of Indian Chironomidae so far. Singh and Maheshwari (1987 a & b) reported that Chandertal (4,270 m. above msl), in the Lahaul-Spiti Valley has a chironomid community of five species. of *Micropsectra*; one species of *Metriocnemus* and three of *Corynoneura*. On the basis of their swarming behaviour, genera can be differentiated: *Micropsectra* spp. swarm over green vegetation while *Metriocnemus* spp. do so over stones and boulders. *Corynoneura* gyrates on the surface of lake water after emergence and each species of *Corynoneura* exhibits a specific pattern of gyration. Maheshwari (1992) studied Chironomidae as indicators of lake typology of Northwest Himalaya and categorized high altitude lakes into subgroups. A key for the classification of high altitude lakes is given below:

KEY TO THE TYPES OF LAKES ON THE BASIS OF CHIRONOMID FAUNA

1. *Paracladopelma* and Tanypodinae present..... Eutrophic lakes (Nanakmata)
   Above absent 2
2. *Heterotrissocladius, Stictochironomus* and *Phaenopsectra* present..... Mesotrophic lakes (Bhimtal, Sattal, Naukuchia Tal, Nainital)
   Micropsectra, Corynoneura, Diamesa, Pseudodiamesa and *Metriocnemus* present.....
   Oligotrophic lakes 3
3. *Corynoneura* and *Micropsectra* (Notocene gp.). present.... zeta-Oligotrophic (Chandertal lake)
   Corynoneura spp. absent 4
4. *Micropsectra himachali, Diamesa dashauhari* and *Pseudodiamesa* present .....
   .....alpha oligotrophic (Dashauhar lake)
   Micropsectra himachali present. *Diamesa* and *Pseudodiamesa* spp. absent .....
   .....beta-oligotrophic...(Suraj Tal)

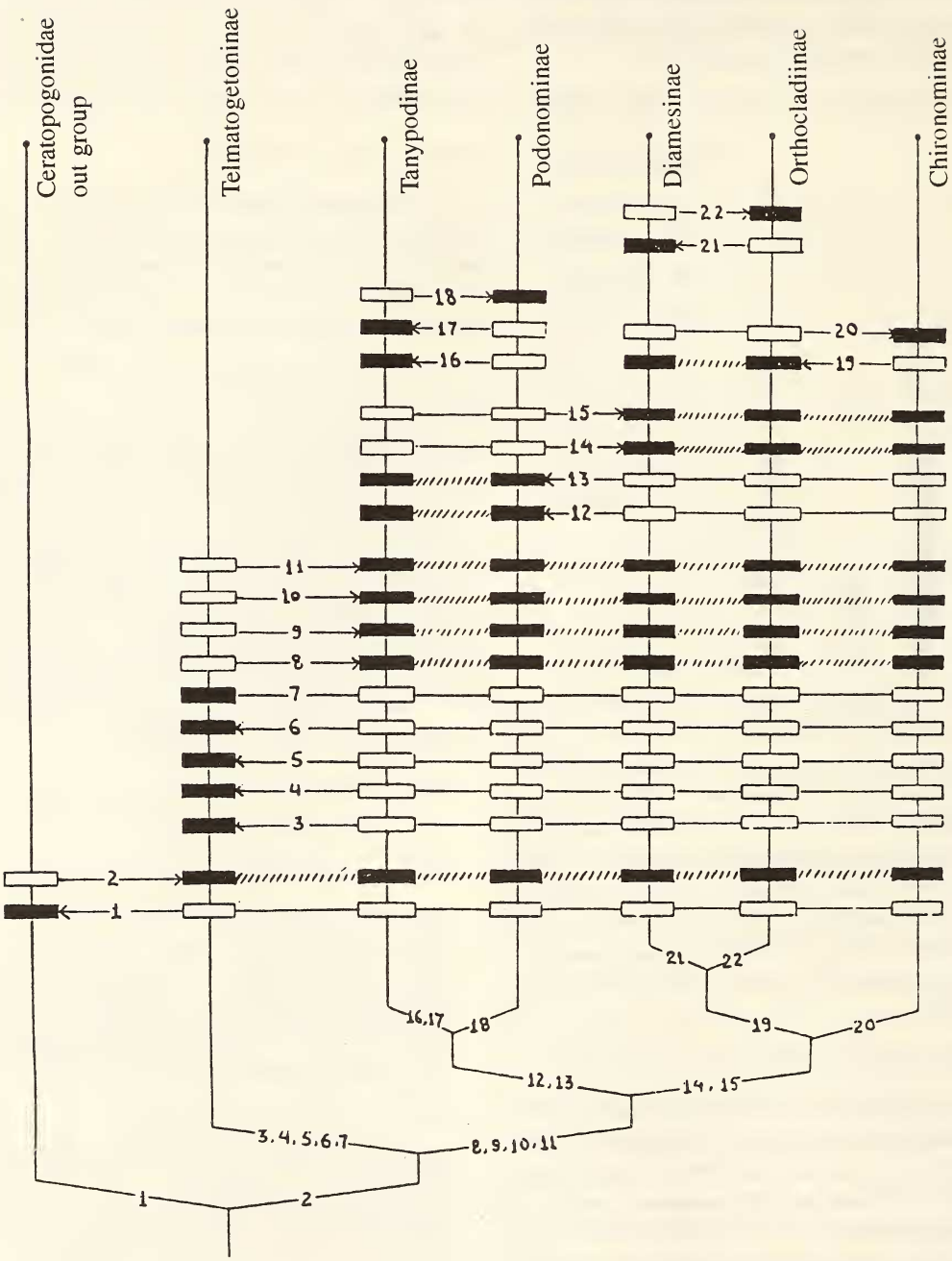

Fig. 2: Scheme of argumentation delineating the cladogenesis of the subfamilies of Chironomidae by means of trends 1-22.

Trends used in the cladistic analysis are being given hereunder (a = apomorphous; p = plesiomorphous)

Trend 1 Notum absent (a); notum present (p)
Trend 2 Anal point present (a); anal point absent (p)
Trend 3 Gonostylus male short and ovoid (a) male gonostylus long, tapering distally (p).
Trend 4 Tergite VIII of female reduced (a); Tergite VIII of female well developed (p).
Trend 5 Gonocoxite IX of female reduced (a); Gonocoxite IX well developed (p).
Trend 6 Female Labia fused (a); Labia separated.
Trend 7 Seminal capsule absent, spermathecal ducts serve as seminal storage organ (a); Seminal capsules present and well developed (p).
Trend 8 Gonapophysis VIII of female very long, elongated (p); Gonapophysis VIII relatively short, single or divided (a)
Trend 9 Gonostylus IX of female present (p); Gonostylus IX of female absent (a).
Trend 10 Gonostylus tooth, X and Y-seta absent (p); either tooth or X and Y- seta present (a).
Trend 11 Aedeagal membrane present in male (p); absent (a)
Trend 12 Tergite and sternite IX of male segment completely fused (a); Tergite and sternite IX not completely fused (p).
Trend 13 Gonocoxite of female reduced and fused with tergite IX to form gonotergite IX(a); both not fused (p).
Trend 14 One pair reduced volsella present (p); volsella 2-4 pairs and well developed (a).
Trend 15 Gonapophysis VIII of female not divided into 1-2 lobes (p); Gonapophysis VIII of female divided into 2-3 lobes (a).
Trend 16 Gonostylus tooth present (a); absent (p)
Trend 17 Gonotergite IX narrow and reduced with very few setae (a); gonotergite hood-shaped with numerous setae (p).
Trend 18 Female gonocoxapodeme VIII weakly developed (p); gonocoxapodeme VIII absent (a).
Trend 19 Tergite IX of female undivided, large, hood shaped (p); tergite IX divided into two setigerous protrusions. If undivided, shortened (a).
Trend 20 Male gonostylus posteriorly directed (a); anteriorly directed (p).
Trend 21 Segment X of male absent (a); segment X present (p).
Trend 12 Notum of female long (a); Notum relatively short (p).

As apparent from this key, the occurrence of specific forms in a particular water body indicate the character of the lake.

The present study reveals that occurrence of Chironomidae is related to the availability of appropriate larval habitat.

The species of tribe Chironomini are thermophilic and adapted to standing water. Tribe Tanytarsini includes rheophilic and thermophilic species. Rheophilic species represented by *Micropsectra* Tokunaga, represented by seven species, are restricted to the Himalayan Region. *Micropsectra chanderi* and *Micropsectra bifurcata* are also adapted to torrential streams. The rest of the *Micropsectra* species are found in the oligotrophic lakes of Himachal Pradesh. *Tanytarsus* Wulp and *Rheotanytarsus* Bause are thermophilic and lentic, while *Stempellina* Bause species are thermophilic and lotic. *Polypedilum* Kieffer species are found in marshy places.

Tanypodinae is represented by tribes Clinotanypodini, Tanypodini, Macropelopiini and Pentaneurini, are thermophilc, with a solitary example of rheophilic *Macropelopia* sp.

Orthocladiinae is a widely distributed group, inhabiting marine, marshy, lotic and lentic habitats in high altitude and low land water bodies. *Symbiocladius* Kieffer inhabits brackish water, running, stagnant water of low land and cold water bodies of Kulu Valley. *Corynoneura* Winn. are restricted to the ultra-oligotrophic lakes of Lahaul-Spiti Valley of Himachal Pradesh. *Cricotopus* Wulp are thermophilic and

TABLE 1

DISTRIBUTION OF INDIAN *CHIRONOMIDAE* IN RELATION TO HABITATS AND WATER CONDITIONS

	HABITATS					
	Marine	Brackish Water	Fresh Water			
			Rheophilous		Thermophilous	
			Lotic	Lentic	Lotic	Lentic
Chironomus	-	-	-	-	+	+
Paratendipes	-	-	-	-	+	+
Omisus	-	-	-	+	-	+
Endochironomus	-	-	-	-	-	+
Polypedilum	-	+	-	-	+	+
Xenochironomus	-	-	-	-	+	-
Microchironomus	-	+	+	-	+	+
Harnischia	-	-	-	-	+	+
Cladopelma	-	-	-	-	+	+
Parachironomus	-	-	-	-	-	+
Goeldichironomus	-	-	-	-	-	+
Glyptotendipes	-	+	-	-	-	+
Dicrotendipes	-	-	-	-	+	+
Leptochironomus	-	-	-	-	-	+
Micropsectra	-	-	+	+	-	-
Tanytarsus	-	-	-	-	-	+
Rheotanytarsus	-	-	-	-	-	+
Stempellina	-	-	-	-	+	-
Clinotanypus	-	-	-	-	+	+
Tanypus	-	-	-	-	+	+
Macropelopia	-	-	+	-	-	-
Pentaneura	-	-	-	-	+	+
Ablabesmyia	-	-	-	+	-	-
Conchapelopia	-	-	-	-	-	+
Cricotopus	-	-	-	-	-	+
Smittia	-	-	-	+	-	+
Krenosmittia	-	-	-	-	+	-
Thalassosmittia	+	-	-	-	-	-
Clinocladius	-	-	+	-	-	-
Metriocnemus	-	-	-	+	-	-
Brillia	-	-	+	-	-	-
Euricnemus	-	-	-	+	-	-
Corynoneura	-	-	-	+	-	-
Abiskomyia	-	-	+	-	-	-
Paraphenocladius	-	-	+	-	-	-
Symbiocladius	-	-	+	+	+	-
Podonomus	-	-	+	-	-	-
Diamesa	-	-	-	+	-	-
Pseudodiamesa	-	-	-	+	-	-

Key: (+) present; (-) absent.

lentic. *Smittia* Holmagren are adapted to thermophilic and rheophilic conditions. *Brillia* Kieffer and *Euricnemus* Wulp are the rarest chironomids of India, inhabiting cold water bodies of Kulu and Lahaul Valley, Himachal Pradesh. *Paraphenocladius* Thienemann is adapted for torrential streams. Among the Orthocladiinae, *Symbiocladius* Kieffer occur as external parasites on mayfly larvae. *Thalassosmittia* is exclusively marine.

During the last ten years, the high altitude lakes Suraj Tal (4864 m above msl), Chandertal (4270 m above msl), (Singh and Maheshwari 1987 a & b) Dashauhar Lake (4200 m above msl), (Singh and Maheshwari 1989), Bhrighu Lake (4132 m above msl), Deepak Tal (4202 m above msl) were explored and faual compositions of each lake was found specific. Dashauhar lake shows domination of *Diamesa-Pseudodiamesa,* whereas Bhrighu, Chandertal and Suraj Tal are dominated by *Micropsectra* species. Deepak Tal, a comparatively small lake, shelters a few species of Orthocladiinae (Maheshwari 1987).

Altitudinal Distribution

Chironomidae are abundant upto 5000 m above msl. A reduction in diversity with increasing altitude is observed in Chironomidae, only 35-40 species occuring over 2000 m. The Chironomini zone ranges 0-400 m above msl and supports 27 species with a single exception of *Glyptotendipes,* which was found between 1800-2000 m above msl (Kulu to Rhala fall). The Tanytarsini zone ranges from 0-5000 m and supports 14 species. *Micropsectra*, a high altitude group of Tanytarsini, is found distributed between 2000-5000 m above msl and represented by seven species (Kulu and Lahaul valley). Orthocladiinae inhabits marine water (Andaman and Nicobar Islands), low land water bodies in the plains of Uttar Pradesh, torrential streams and Himalayan lakes (Chandertal, Deepak Tal and Bhrighu lake). Podonominae and Diamesinae are exclusively hypsobiont and generally found above 2000 m.

Discussion

Although great overlaps occur, especially in the lower mountain and low land categories, there are distinct shifts in the Chironomidae community with increasing height. Substrate type and available food influences chironomid distribution as much as temperature. Most hypsobiont species have optimum temperature near their minimum tolerance value, whereas the warm water species or eurythermic species have a wider range of tolerance. The cold stenothermic species. were represented by *Diamesa, Pseudodiamesa* and some Orthocladiinae, those are restricted in ultra-oligotrophic lakes such as Dashauhar (Pir Panjal Range) and Suraj Tal lake (Great Himalayan Range). Similarly, *Corynoneura* spp. are only found in specific niches of Chandertal Lake in Lahaul Valley. On the other hand, *Micropsectra* are distributed throughout the Himalaya and adapted to lotic and lentic water bodies. Algal grazers such as Diamesinae and a few Orthocladiinae can dominate in glacial brooks and lakes. At the foothills, the shade of riparian vegetation diminishes algal grazer and increases scraper and collector species. This group comprises Tanytarsini, some Chironomini and most Orthocladiinae. In low land water bodies, due to low water velocity and high amount of particulate organic matter, filter and deposit feeding *Rheotanytarsus* and some species of Chironomini predominate.

Acknowledgements

We thank Prof. G.M. Ram, former Principal, St. John's College, Agra for facilities. We also thank Dr. Ipe M. Ipe, Principal and Dr. Santokh Singh, former Head, School of Entomology, St. John's College, Agra for encouragement and Prof. Ole Saether, Director, Museum of Zoology, University of Bergen, Norway for his comments.

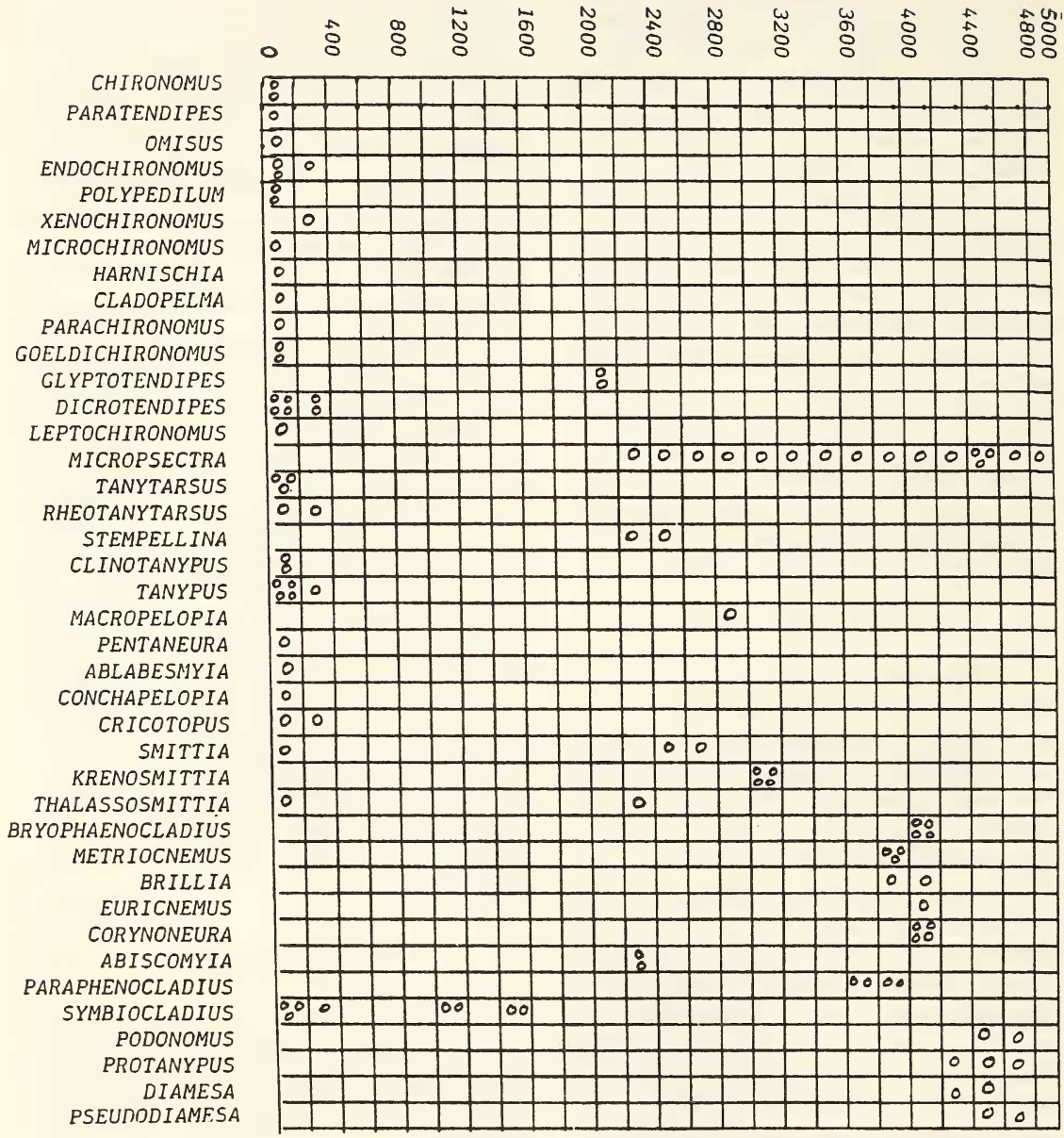

Fig. 3: Altitudinal distribution of Chironomidae

REFERENCES

CHAUDHURI, P.K. & D.C. SINHARAY (1983): A study on Orthocladiinae (Diptera: Chironomidae) of India. The genus *Rheocricotopus* Thienemann and Harnisch. *Ent. Bas, 8*: 298-407.

CHAUDHURI, P.K. & M. GHOSH (1981): Record of *Chaetocladius* Kieffer (Diptera: Chironomidae) from India. *F. Ent. Hungarica. 1*: 5-7.

CHAUDHURI, P.K. & M. GHOSH (1982): Orthocladid midges of genus *Orthocladius* Vander Wulp (Diptera; Chironomidae) from eastern Himalaya. *Annals Zoologica. 36 (25)*: 491-500.

EDWARDS, F.W. (1969): Some Chironomidae (Diptera) from Berkuda Islands, Chilka Lake (India). *Rec. Indian Mus. 34(2)*: 177-183.

GOETGHEBUER, M. (1914): Contribution a l'etude des Chironomides de Belgique. *Annals Biol. Lacustre 7*: 66-72.

KAUL, B.K. (1970): Torrenticole insects of the Himalaya. II. Two new Diamesini (Diptera: Chironomidae). *Oriental Ins. 4(3)*: 293-297.

KIEFFER, J.J. (1910): Etude sur les Chironomides des Index Orientales. *Mem. Indian Mus. 2*: 181-242.

KIEFFER, J.J. (1911): Chironomidae (Indian Ocean). *Trans. Linn. Soc. London 14(2)*: 315-366.

KIEFFER, J.J. (1911a): Les Chironomidae (Tendipedidae) de L'Himalaya et d'Assam. *Rec. Indian Mus., 9*: 118-197.

KIEFER, J.J. (1914): Quel ques nouvaux des Chironomides des Index. *Rec. Indian Mus. 10*: 313-315.

MAHESHWARI, GIRISH (1986): Bioecology of the *Chironomus* spp. found in the filter beds of Civil Water Supply System of Agra. (Diptera: Chironomidae) Ph.D. Thesis, Agra University, Agra.

MAHESHWARI, GIRISH (1987): A new species of Tanytarsini from India (Diptera: Chironomidae). *Entomon 12(2)*: 207-210.

MAHESHWARI, GIRISH (1989): Mating Behaviour of Chironomidae (Diptera). *Proc. V. Indian Symp. Invertebrate Reproduction* 377-383.

MAHESHWARI, GIRISH (1989a): Distributional Pattern of high altitude Chironomidae (Diptera). St. John's College, *Science Spectra 1(1)*: 131-137.

MAHESHWARI, GIRISH (1989b): Redescription of two *Chironomus* spp. from India. (Diptera: Chironomidae). *Acta. Biol. Debr. Oecol. Hung., 2*: 253-264.

MAHESHWARI, GIRISH (1990): Role of rice midges in agroecosystem of paddy and in pollination of flowering plants. Participants seminar of Insect Plant Interaction ERI Madras: 14 (Summary).

MAHESHWARI, GIRISH (1992): Behavioural ecology of Chironomidae (Diptera) from northwest Himalaya. DST Project report (unpublished).

MAHESHWARI, GIRISH (1995): Some peculiar behaviour of high altitude Chironomidae. *Chironomus (3)*: 13-14.

MAHESHWARI, GIRISH & GEETA AGARWAL (1993): Taxonomy of Harnischia complex from India with a short note on their seasonal occurrence. *Comp. Physiol. Ecol. 18(4)*: 169-175.

SINGH, SANTOKH (1958): On a collection of nival Chironomidae (Diptera) from the Northwest Himalaya. *Proc. Nat. Acad. Sci.* (India), Allahabad (B), *28(2)*: 304-314.

SINGH, SANTOKH & A.K. KULSHRESHTHA (1975): Three new spp. of *Tanytarsus. Oriental Ins. 9(4)*: 419-424.

SINGH, SANTOKH & A.K. KULSHRESTHA (1977): *Dicrotendipes rajasthani* nov. sp. from India. *Ent. Scand., 7(2)*: 155-158.

SINGH, SANTOKH & GIRISH MAHESHWARI (1987a): Swarming ecology of Chironomidae (Diptera) of high altitude lake Chandertal (Northwest Himalaya*). Ad. Bios. 6(2)*: 179-186.

SINGH, SANTOKH & GIRISH MAHESHWARI (1987b): Chironomidae of Chandertal Lake, Northwest Himalaya (Diptera: Chironomidae). *Annals. Ent. 5(2)*: 11-20.

SINGH, SANTOKH & GIRISH MAHESHWARI (1989): Biosystematic Study of Diamesa Meigen from India. *Acta. Biol. Debr. Oecol. Hung., 2*: 343-254.

TOKUNAGA, M. (1959): A new midge from Kashmir (Diptera: Tendipedidae*) Akitu.* 8: 21-24.

■ ■ ■